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A METHOD OF CATALYTIC REMOVAL OF ORGANIC IMPURITIES AND CARBON MONOXIDE FROM GASES

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16. Abstract

The object of this invention is a method of removal, through catalytic combustion, of organic impurities and carbon monoxide from the flue gases of industrial plants and from the exhaust gases of internal combustion motors.

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A METHOD OF CATALYTIC REMOVAL OF ORGANIC IMPURITIES AND CARBON MONOXIDE FROM GASES*

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The object of this invention is a method of removal, through catalytic combustion, of organic impurities and carbon monoxide from the flue gases of industrial plants and from the exhaust gases of internal combustion motors. /1***

The known methods of removing organic impurities and carbon monoxide from gases rely most frequently on the oxidation on platinum-group metal catalysts.

Those catalysts accelerate the reaction of combining oxygen with organic compounds, and lower the temperature of the process. The high cost of platinum-group metal catalysts and their high susceptibility to poisoning, which is generally irreversible, impose limitations on the application of those catalysts for the purification of gases. There are also methods for completing combustion of hydrocarbons and

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**M. Eng., co-inventor. Patent owner: Institute of Heavy Organic Synthesis, Blachownia Slaska (Poland).

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carbon monoxide on oxides of certain metals, such as Ni, Co, Cr, Cu, and others. However, the relatively high temperature of the process and a low activity of those catalytic systems, in comparison with the platinum-group metals, are reasons for their limited application in industrial practice.

The method of catalytic removal of organic impurities and carbon monoxide from gases, according to this invention, consists of burning these impurities on a copper-zinc catalyst deposited on an active carrier, such as, for instance, γ-alumina or commercial varieties of aluminum oxide. Copper and its oxides have a limited capacity for /2
catalyzing the combustion reaction. However, it was found unexpectedly that introduction of a zinc component into the copper deposited on an active carrier activates the resultant catalyst, both in the direction of acceleration of the reaction of burning hydrocarbons, and lowers the temperature of the process.

According to this invention, the process of removal of organic impurities and CO takes place on a catalyst prepared by saturation of the carrier with a solution of copper and zinc nitrates. This soaking lasts at least 10 hours, preferably for about 24 hours, and then the catalyst is dried in the stream of air at the temperature $20 - 105^\circ$ C. Subsequently, the catalyst is reduced in the stream of hydrogen at the temperature of $180 - 350^\circ$ C, and then cooled by nitrogen to a temperature below 80° C.

The reduced catalyst is saturated again with the mixture of aqueous nitrates of copper and zinc, and is dried and then reduced in a stream of hydrogen.

This twice-performed saturation deposits on the carrier from 1 to 80 weight parts of the active metals. The weight ratio of the sum of metals to the carrier is established according to the requirements for the catalyst. Also, the numerical ratio of copper to zinc is selected depending on the amount and type of organic impurities and CO contained in gases which are to be purified.

The catalyst prepared in this way is introduced into the reactor, and then gases, contaminated with gases or vapors of organic compounds and CO, are passed through the reactor at an appropriate velocity at a temperature of 200 - 700° C. In this way, the gas becomes purified from the initial content of the order of several percent, to trace values, or complete removal of contaminants. /3

Examples given below illustrate the method of removal of organic impurities and carbon monoxide from gases, according to this invention.

Example I. 170 g $Cu\ (NO_3)_2 \cdot 3\ H_2O$ and 100 g $Cu\ (NO_3)_3 \cdot 6\ H_2O$ were dissolved in 330 g water. 100 g $\gamma\text{-}Al_2O_3$ in the form of granules of dimensions 5 - 10 mm were poured into the solution, and left standing for 24 hours. After this time, the excess of solution was poured off from the vessel, and the saturated carrier was poured into a pipe heated electrically, and dried in a stream of hot air until the temperature 110° C was reached. After the drying, the catalyst was purged with nitrogen and reduced in a stream of hydrogen at a temperature of 180 - 300° C, and then cooled with nitrogen to 20° C. The cycle of saturation, drying, and reduction was repeated. 100 g of the catalyst prepared in this way was poured into a glass reactor with a diameter of 15 mm equipped with an electrical heating spiral. The reactor was then heated to 600° C. At this temperature, a mixture of air and methane was passed through the reactor at a velocity of 400 Nl/hour. After passing through the catalyst layer, the methane content fell from the initial value of 2% to the value of 0.01%, by volume.

Example II. The reactor was filled with the catalyst as in Example I. A mixture of air and ethylene was passed through this reactor at 250° C, at the velocity of 400 Nl/hour. After passing through the catalyst layer, the contents of ethylene were reduced from the initial value of 2% to a value below 0.01%, by volume.

Example III. A mixture of air and benzene was passed at 250° C at the velocity 400 Nl/hour through the reactor, filled with the catalyst as in Example II. After passing through the catalyst layer, the benzene content was lowered from the initial value of 2% to a value below 0.01%, by volume.

Example IV. A mixture of air and carbon monoxide was passed at the temperature 230° C through the reactor filled with the catalyst, as in Example I. After passing through the catalyst layer, /4 the carbon monoxide content decreased from the initial value of 2% to a value below 0.005%, by volume.

Example V. The reactor was filled with the catalyst as in Example I. A mixture of air with vapors of acrolein was passed through this reactor at 230° C, at the velocity 400 Nl/hour. After passing through the catalyst layer, the organic substance content was reduced from the initial value of 2% to a value below 0.005%, by volume.

Example VI. The reactor was filled with the catalyst as in Example I. A gaseous mixture was passed through this reactor at 260° C, at the velocity of 400 Nl/hour. The mixture consisted of the following parts by volume: 70% nitrogen, 22% water vapor, 5% oxygen, 2.9% organic substances containing acrolein, acrylonitrile, acetic anhydride, and acetic acid, and 0.1% H_2S. After passing through the catalyst layer, the total organic substance content fell below 0.005%, by volume.

As is seen from the above examples, this invention enables one to carry out the process of purification of gases from organic contaminants in a broad range of temperatures and for a large variety of substances. An advantage of the method of this invention is that compounds of sulfur are relatively harmless to the catalyst. Susceptibility of catalysts to poisoning by sulfur compounds eliminates in many cases methods based on the platinum-group metal catalysts.

These advantages, as well as the low cost of the copper-zinc catalysts, in comparison with the platinum-type catalysts, make is possible to apply this method on an industrial scale.

Patent Claims

1. A method of catalytic removal of organic impurities and carbon monoxide from gases, characteristic in that in the process of combustion of impurities a copper-zinc catalyst is used, which is precipitated from an aqueous solution of copper and zinc nitrates and deposited on a carrier, the sum of active metals in the catalyst ranges from 1 to 80 parts by weight.

2. A method according to Claim 1, characteristic in that the catalist is saturated at least twice with solutions of copper and zinc nitrates, and after each saturation the catalyst is subjected to the operation of drying at a temperature 150° - 400° C.

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